CLAIMS

What is claimed is:

1. A catalyst regenerator comprising:

a first section containing a carbon-contaminated catalyst and receiving an oxygen-containing gas at a flow rate, wherein the first section has a first width and first volume;

a second section fluidly coupled to the first section, wherein the second section has a second width and second volume;

wherein the first width and first volume and the second width and second volume are configured such that at the flow rate (a) the oxygen-containing gas has a residence time in the first section effective to selectively produce carbon monoxide from the carbon-contaminated catalyst, (b) the oxygen-containing gas has a residence time in the second section effective to produce carbon dioxide from the carbon monoxide; and

wherein the flow rate in the first section is higher than the flow rate in the second section.

2. The catalyst regenerator of claim 1 wherein the first section and the second section have a substantially circular horizontal cross section.

3. The catalyst regenerator of claim 2 wherein the first section has a first height H_1 and a first diameter D_1, wherein the second section has a second height H_2 and a second diameter D_2, and wherein D_2:D_1 is at least 2.5 and H_2:H_1 is at least 0.6.

4. The catalyst regenerator of claim 1 wherein the carbon-contaminated catalyst has a temperature of less than 700°F.

5. The catalyst regenerator of claim 1 wherein the first section is configured such that the carbon-contaminated catalyst is fluidized in the first section at least in part at the flow rate of the oxygen-containing gas.

6. The catalyst regenerator of claim 1 wherein second section is configured such that the residence time of the oxygen-containing gas in the second section is sufficient to precipitate substantially all of the carbon-contaminated catalyst carried over from the first section.

7. The catalyst regenerator of claim 1 wherein the second section receives a second oxygen-containing gas comprising molecular oxygen.

8. The catalyst regenerator of claim 7 wherein the oxygen-containing gas received in the first section comprises an amount of molecular oxygen that is substantially equal or less than an amount required to convert substantially all of the carbon of the carbon-contaminated catalyst to carbon monoxide in the first section.

9. The catalyst regenerator of claim 1 wherein the oxygen-containing gas in the second section has a temperature of less than 1100°F.

10. The catalyst regenerator of claim 1 wherein the carbon-contaminated catalyst is continuously provided to the first section.

11. The catalyst regenerator of claim 1 further comprising a catalyst coupled to the second section that converts carbon monoxide to carbon dioxide.

12. A catalyst regenerator comprising:
a first section having a first height H1 and a first diameter D1 and second section having a second height H2 and a second diameter D2, wherein D2:D1 is at least 2.5, H2:H1 is at least 0.6;
wherein carbon from a carbon-contaminated catalyst is selectively converted to carbon monoxide in the first section using an oxygen containing gas, and wherein the carbon monoxide from the first section is selectively converted to carbon dioxide in the second section; and
wherein a flow rate of the oxygen containing gas is higher in the first section than in the second section.

13. A method of regenerating a catalyst comprising:
providing a regenerator vessel having a first section fluidly coupled to a second section, wherein the first section contains carbon-contaminated catalyst;
feeding an oxygen-containing gas at a predetermined flow rate to the first section;
wherein the first section is configured to provide a residence time of the oxygen-containing gas effective to selectively produce carbon monoxide from the carbon-contaminated catalyst;

wherein the second section is configured to provide a second residence time of the oxygen-containing gas and carbon monoxide effective to produce carbon dioxide from the carbon monoxide; and

wherein the flow rate in the first section is higher than in the second section.

14. The method of claim 13 wherein the first section has a first height H_1 and a first diameter D_1, wherein the second section has a second height H_2 and a second diameter D_2, and wherein D_2:D_1 is at least 2.5 and H_2:H_1 is at least 0.6.

15. The method of claim 13 further comprising operating the first section at a temperature of less than 700°F and operating the second section at a temperature of less than 1100°F.

16. The method of claim 13 wherein the second residence time of the oxygen-containing gas and carbon monoxide in the second section is sufficient to precipitate substantially all of the carbon-contaminated catalyst carried over from the first section.

17. The method of claim 13 further comprising feeding a second oxygen-containing gas comprising molecular oxygen to the second section.

18. The method of claim 13 wherein the oxygen-containing gas of the first section comprises an amount of molecular oxygen that is substantially equal or less than an amount required to convert substantially all of the carbon of the carbon-contaminated catalyst to carbon monoxide in the first section.

19. The method of claim 13 further comprising continuously providing the first section with carbon-contaminated catalyst.

20. The method of claim 13 further comprising coupling a catalyst to the second section that converts residual carbon monoxide to carbon dioxide.